

## Test Report

- Translation -

Document No.: (3764/829/09) – NB dd. 10/03/2009

Client: FRIULSIDER SPA  
Via Trieste 1  
33048 San Giovanni al Natisone  
Italy

Order date: 09/03/2009

Order Ref.: Ms Novello

Order received: 09/03/2009

Subject: “Friulsider Injection system KEM-UP 934” bonded anchors, placed in non-cracked RC members and subjected to centric tension loads, to be tested and evaluated in connection with anchor rods (dimensions M8 to M30) for their reaction to fire to determine their fire resistance time for one-sided fire exposure

Test basis: DIN EN 1363-1 : 1999-10

Test material received: 11/06/2008

Sampling: Sampling information is not available to the Testing House.

Test material marking: None

Test date: 27/06/2008, 27/08/2008, 01/09/2008 and 30/09/2008

Valid until: 7 January 2014



This Test Report consist of 8 pages, incl. cover sheet and 8 annexes.

Test Report No. (3764/829/09) – NB dd. 10/03/2009 does not replace the building code attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA) required under the German building code procedure.

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## 1 Background and general statement

Under the order placed with the Testing House, a Test Report was to be drawn up on the reaction to fire of “Friulsider Injection system KEM-UP 934” bonded anchors, which are subjected to centric tension and tested for steel failure / bonding failure on the basis of section 2.3 of TR 020 : 2004-05, when exposed to a fire in compliance with DIN EN 1363-1 : 1999-10 to determine their fire resistance time.

### Related documents:

- (1) DIN EN 1363-1 : 1999-10, Fire resistance tests - Part 1: General requirements,
- (2) EOTA Technical Report TR 020 : 2004-05 - Evaluation of anchorages in concrete concerning resistance to fire,
- (3) “Friulsider Injection system KEM-UP 934”, European Technical Approval ETA-09/0061 of 16-02-2009, issued by DIBt, Berlin,
- (4) is a transfer of Test Report No. (3302/252/08)-NB dated 07-01-2009 (english translation, the german version of Test Report No. (3302/252/08)-NB dated 07-01-2009 is the only legally binding text). The injection adhesive anchors evaluated in the present Test Report

are per statement of the client identical with the anchors evaluated in the Test Report No. (3302/252/08)-NB.

Using the results achieved in the fire test, the “Friulsider Injection system KEM-UP 934” bonded anchors were to be examined and evaluated respecting requirements (steel failure, pullout) specified in EOTA Technical Report TR 020 : 2004-05.

## **2 Description of system tested**

The “Friulsider Injection system KEM-UP 934” bonded anchor is an injection system that uses the bonding effect between anchor rod, bonding mortar and concrete to become anchored in the substrate. According to the type approval for cold design of anchoring means primarily subjected to static loads, the “Friulsider Injection system KEM-UP 934” bonded anchor may be used in reinforced and non-reinforced normal-weight concrete (strength class C20/25 as a minimum and C50/60 as a maximum) in the non-cracked concrete.

Main elements of the tested “Friulsider Injection system KEM-UP 934” bonded anchor are a two-component mortar cartridge (injection mortar: based on epoxy resin with amine hardener and silica flour) and cold-formed anchor rods (dimensions M8 to M30), together with a hexagon nut and a washer. The anchor rods and the nuts and washers are made from electrogalvanised steel (strength class 5.6). Forces are transmitted by the bond stress between the anchor rod and the anchoring substrate. For the service conditions, the “Friulsider Injection system KEM-UP 934” bonded anchor is regulated with the European Technical Approval ETA-09/0061.

As specified in the above type approval, the “Friulsider Injection system KEM-UP 934” bonded anchors were installed with the installation tools (hammer drill and drill, cleaning device and injection device) defined in these documents.

Further structural details and details of the as-installed condition of the bonded anchors are shown annexes 1.1 to 1.4 of this Test Report.

## **3 Test set-up and testing**

The “Friulsider Injection system KEM-UP 934” bonded anchors were fire tested in a small-sized furnace with the inside dimensions 1,000mm x 1,500mm x 1,500mm (WxDxH). RC slabs (strength class C20/25) formed the horizontal barrier, into the tension zones of which the “Friulsider Injection system KEM-UP 934” bonded anchors were placed.

In compliance with TR 020 : 2004-05, section 2.3.1, external loading systems and protected steel elements (dead loads) of the required weight, which were suspended for an unsupported and

unprotected length of  $l \leq 500\text{mm}$  with tension rods and an additional steel adapter, were used for introducing the centric loads into the “Friulsider Injection system KEM-UP 934” bonded anchors.

The furnace was exposed to a fire in compliance with the standard temperature-time curve (ETK) as specified in DIN EN 1363-1 : 1999-10, section 5.1.1. The temperatures in the furnace were measured with 2 plate thermometers made from Ni-Cr/Ni-Al  $\varnothing$  1.0mm wire (type K) in compliance with DIN EN 1363-1 : 1999-10, section 4.5.1.1.

The temperatures measured in the furnace during the fire tests are illustrated by the graphs in annexes 2.1, 3.1, 4.1, and 5.1.

## 4 Test results, evaluation and conclusions

### 4.1 Evaluation of test results respecting centric tension loading

On 27/06/2008, 27/08/2008, 01/09/2008 and 30/09/2008, a total of 26 “Friulsider Injection system KEM-UP 934” bonded anchors were placed in the non-cracked tension zone of RC floor sections (strength class C20/25) and tested for their reaction to fire when subjected to centric tension loads in compliance with DIN EN 1363-1 : 1999-10 to determine their fire resistance time.

Tables 4-1 to 4-5 in Test Report No. (3302/252/08) – NB dated 07-01-2009 list the test results for the 26 “Friulsider Injection system KEM-UP 934” bonded anchors in connection with anchor rods made from electrogalvanised steel (strength class 5.6) and make reference to the cause of failure.

### 4.2 Evaluation of test results respecting steel failure

#### 4.2.1 General

The basis used for evaluation was section 2.3.1 of EOTA Technical Report TR 020 : 2004-05:

$$\sigma_{s1} = c_1 + c_2 / t_u \quad \text{equation: regression curve}$$

$$\sigma_{s2} = c_3 (c_1 + c_2 / t_u) \quad \text{equation: design curve}$$

Equations for determination of the characteristic steel stress for fire resistance times of 60 min., 90 min. and 120 min:

$$\sigma_{Rk,s,fi(60)} = c_3 (c_1 + c_2 / 60\text{min})$$

$$\sigma_{Rk,s,fi(90)} = c_3 (c_1 + c_2 / 90\text{min})$$

$$\sigma_{Rk,s,fi(120)} = c_3 (c_1 + c_2 / 120\text{min})$$

Equation for determination of the characteristic steel stress for fire resistance times of 30 min., using the equation of the straight line through points  $t_u = 60 \text{ min} / \sigma_{Rk,s,fi(60)}$  and  $t_u = 90 \text{ min} / \sigma_{Rk,s,fi(90)}$ :

$$\sigma_{Rk,s,fi(30)} = C_4 - C_5 \times 30 \text{ min}$$

To calculate the tensile stress, the stress cross section  $A_s$  of the corresponding diameter of the “Friulsider Injection system KEM-UP 934” bonded anchors was entered in the computation. Separate assessments were made for dimensions M8 to M20. The assessments for dimensions M24 to M30 are based on the test results for diameter M20.

#### 4.2.2 Presentation of test results and evaluation

The graphs in Fig. 4.1 show the test results as a function of the stress  $\sigma_s$  of the “Friulsider Injection system KEM-UP 934” bonded anchors made from electrogalvanised steel (strength class 5.6) when subjected to centric tensile loads.

The “Friulsider Injection system KEM-UP 934” bonded anchors with the dimensions M24 to M30 are evaluated on the basis of the steel stress utilisation level in relation to the stress cross section.

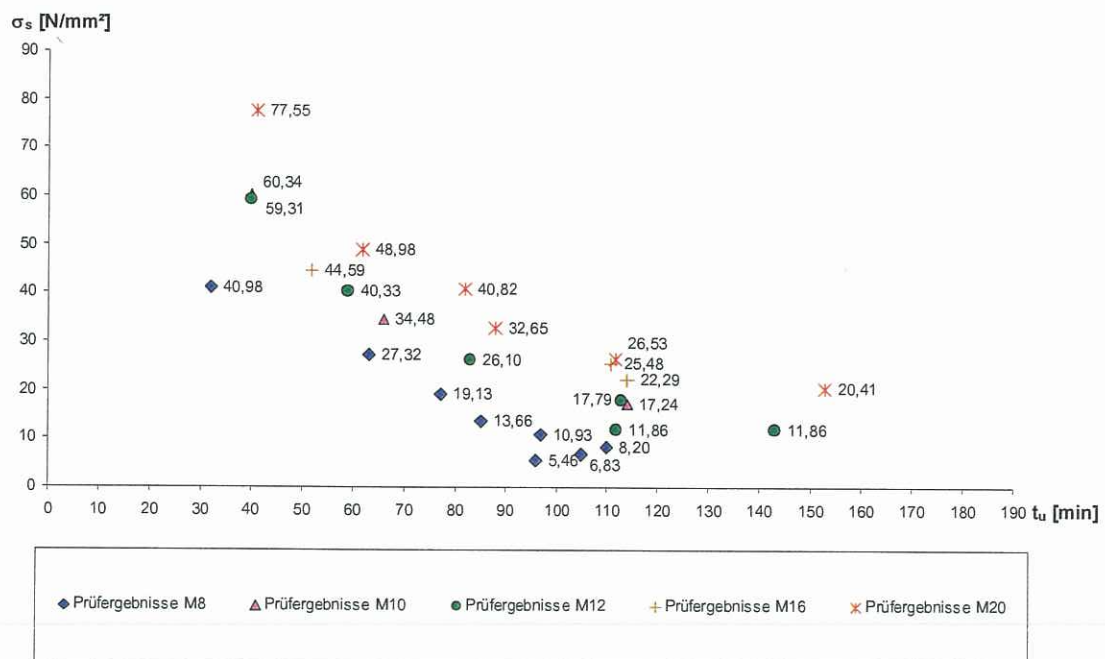


Fig. 4-1: Graphic representation of test results (steel failure, bonding failure) determined for the “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 to M20) in connection with anchor rods made from electrogalvanised steel (strength class 5.6)

#### 4.2.3 Proposed rating for the “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 to M30) in connection with anchor rods made from electrogalvanised steel (strength class 5.6)

Using the test results achieved for “Friulsider Injection system KEM-UP 934” bonded anchors made from electrogalvanised steel (strength class 5.6) as a basis, fire resistance periods are proposed for the “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 to M30) made from electrogalvanised steel (strength class 5.6, 5.8 and 8.8) as a function of the maximum centric tensile load as shown in table 4-1 below.

Based on the results achieved in the tests, and departing from the evaluation specifications in TR 020 : 2004-05, the ratings for “Friulsider Injection system KEM-UP 934” bonded anchors made from galvanised steel have been increased with regard to the 30-minute fire resistance time.

Table 4-1: Proposed rating for “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 – M30) made from electrogalvanised steel, regarding their fire resistance times as a function of stress  $\sigma_s$  when exposed to centric tensile loads, and as a function of the minimum set depth

Designation	“Friulsider Injection system KEM-UP 934” bonded anchor							
	Maximum tensile load <sup>1)</sup>							
	F [kN]							
Fire resistance time $t_u$ [min]	M8	M10	M12	M16	M20	M24	M27	M30
Minimum set depth [mm]	80	90	110	125	170	210	250	280
30	0.90	3.20	4.20	8.25	17.25	24.85	32.30	39.50
60	0.50	1.80	2.30	5.30	10.20	14.75	19.15	23.40
90	0.30	1.10	1.40	3.80	6.70	9.70	12.60	15.40
120	0.20	0.75	0.90	3.00	5.00	7.20	9.30	11.35

<sup>1)</sup> Loads resulting from European Technical Approval ETA-09/0061 may be decisive for the service condition.

#### 4.2.4 Proposed rating for “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 – M30) in connection with anchor rods made from stainless steel


Starting from the results achieved in the tests, the same characteristic tensile stresses (cf. table 4-1) are recommended for the “Friulsider Injection system KEM-UP 934” bonded anchors, when adequate anchor rods and nuts made from stainless steel (material No. 1.4401 (A4) and 1.4571 (A5), 1.4529 (HCR) strength class 50 and 70, respectively) are used.

## 5 Annotations

- 5.1** This Test Report does not replace the required building code attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA). It should, in particular, be noted that the fire load density values of “Friulsider Injection system KEM-UP 934” bonded anchors can be regulated by European Technical Approvals.
- 5.2** The above evaluation shall only apply to the tested “Friulsider Injection system KEM-UP 934” bonded anchors, due consideration being given to the boundary conditions shown in the technical annexes attached to this Test Report and/or the technical data sheets of Friulsider Spa.
- 5.3** The “Friulsider Injection system KEM-UP 934” bonded anchors may be used for anchoring applications in non-cracked reinforced concrete (strength class C20/25 as a minimum and C50/60 as a maximum) when primarily subjected to static loads.
- 5.4** The evaluation shall only apply in connection with members made from reinforced concrete, which can as a minimum be classified under the same fire resistance class as that of the anchors.
- 5.5** The validity of the Test Report will expire on 7 January 2014.

  
ORR Dr.-Ing. Rohling  
Head of Testing Laboratory



i.A.   
Dipl.-Ing. Bollmohr  
Engineer in charge

Braunschweig, dated 10 March 2009

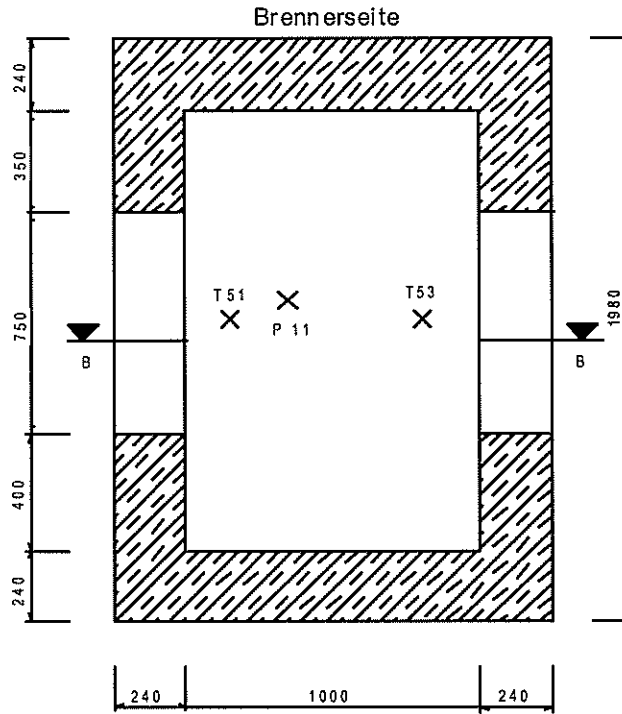
## List of annexes

- Annex 1.1 : Structural design of the test installation
- Annex 1.2 : “Friulsider Injection system KEM-UP 934” bonded anchors after installation
- Annex 1.3 : Technical details of the bonded anchors
- Annex 1.4 : Technical details of the bonded anchors
- Annex 2.1 : Furnace temperatures – test 1
- Annex 3.1 : Furnace temperatures – test 2
- Annex 4.1 : Furnace temperatures – test 3
- Annex 5.1 : Furnace temperatures – test 4

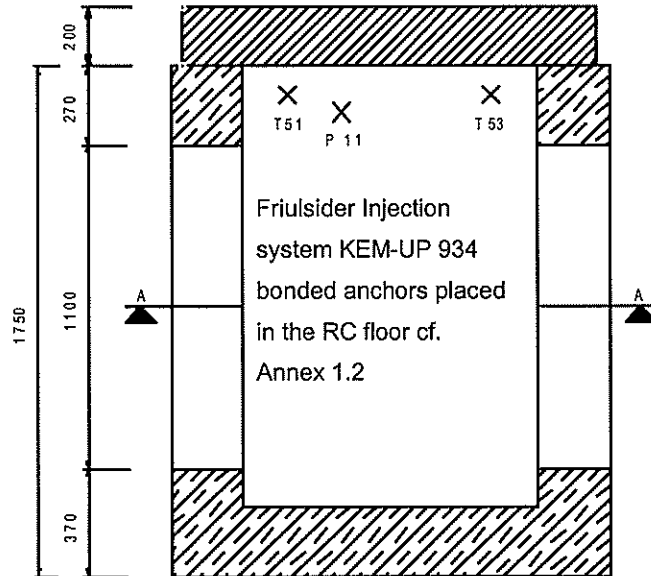


Furnace: chamber 6

Schnitt A-A



Schnitt B-B Deckenelement



T51 and T53 measuring points of furnace temperature, thermocouples with measuring points made of Ni-Cr/Ni-Al-wires (type K)  
P11 Pressure measuring head

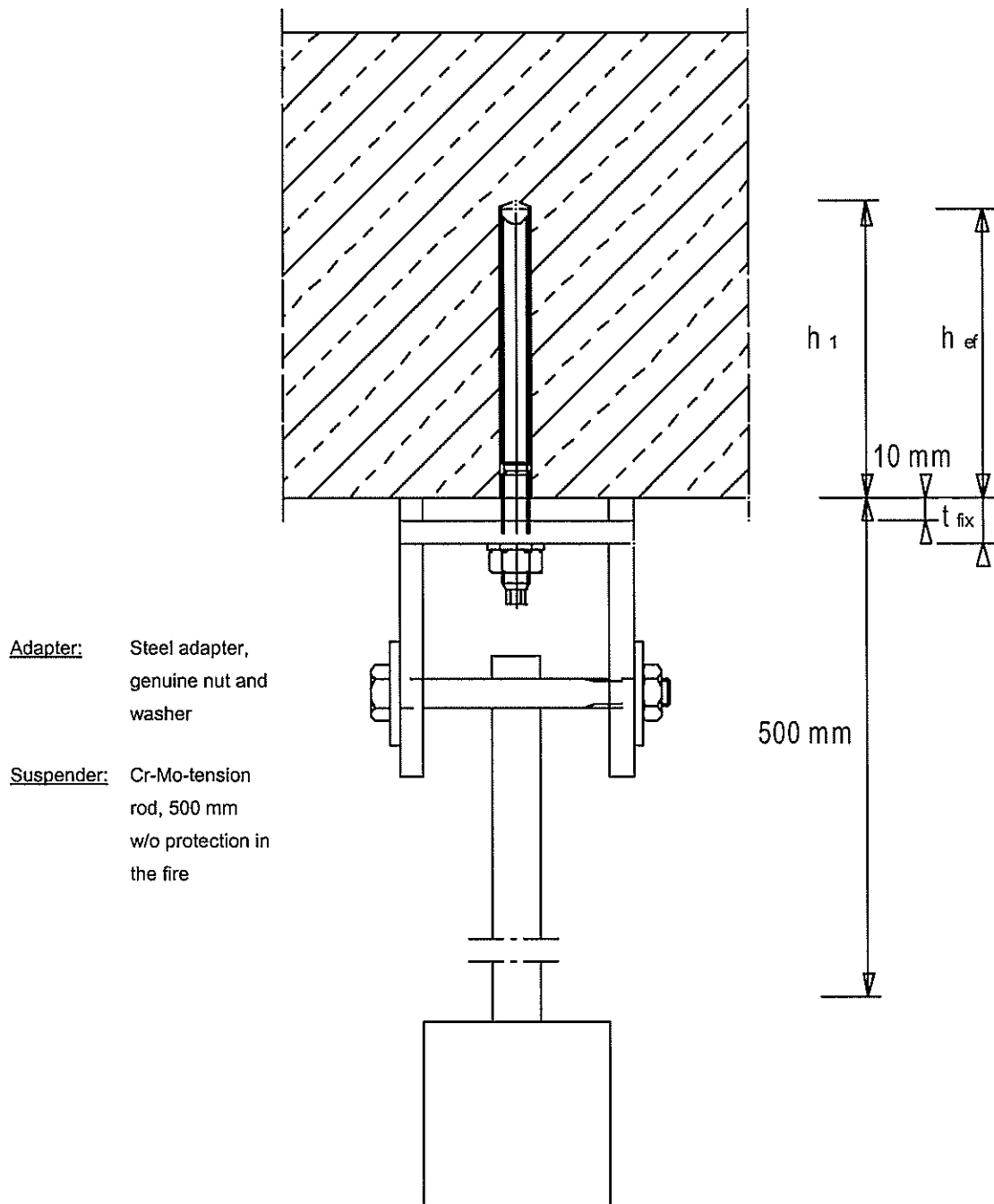
Dimensions in mm

**Structural design of the test installation**  
Installation of test chamber

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Annex 1.1 of  
Test Report No.  
(3764/829/09)-NB

**“Friulsider Injection system KEM-UP 934” bonded anchors placed in RC slab  
d ≥ 200mm / C 20/25**



**Installation situation of sample**  
“Friulsider Injection system KEM-UP 934” bonded anchors

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Annex 1.2 of  
Test Report No.  
(3764/829/09)-NB

## “Friulsider Injection system KEM-UP 934” bonded anchors

### Materials (Threaded rod)

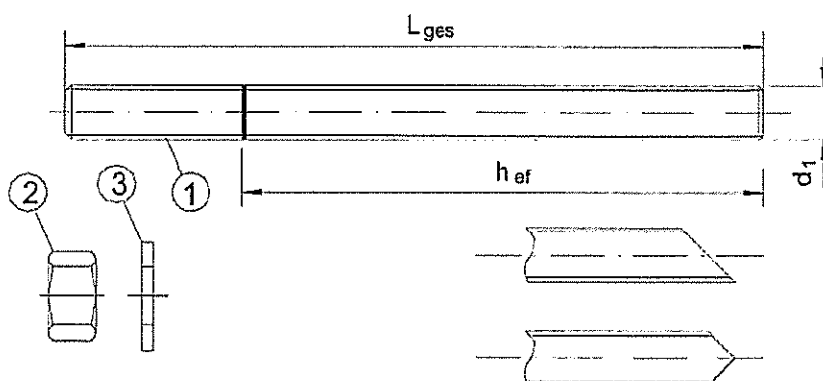


Tabelle: Materials

Part	Designation	Material
<b>Steel, zinc plated <math>\geq 5 \mu\text{m}</math> acc. to EN ISO 4042 or Steel, hot-dip galvanised <math>\geq 40 \mu\text{m}</math> acc. to EN ISO 1461</b>		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 5.8, 8.8, EN ISO 898-1:1999
2	Hexagon nut, EN 24032	Property class 5 (for class 5.8 rod) EN 20898-2, Property class 8 (for class 8.8 rod) EN 20898-2
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Steel, zinc plated
<b>Stainless steel</b>		
1	Anchor rod	Material 1.4401 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 $\leq$ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN 24032	Material 1.4401 / 1.4571 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 $\leq$ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4401 or 1.4571, EN 10088
<b>High corrosion resistance steel</b>		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 $\leq$ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN 24032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 $\leq$ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088

### Technical data

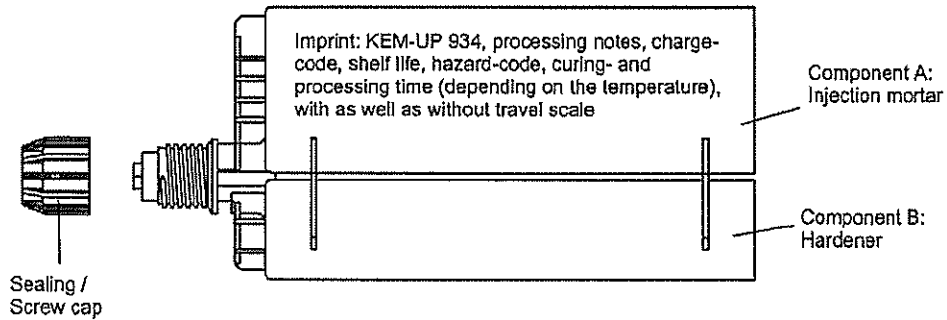
“Friulsider Injection system KEM-UP 934” bonded anchor

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der Technischen Universität Braunschweig

Annex 1.3 of  
Test Report No.  
(3764/829/09)-NB

## “Friulsider Injection system KEM-UP 934” bonded anchors

385 ml, 585 ml and 1400 ml Injection mortar cartridge (Type: “side-by-side”)



Static Mixer

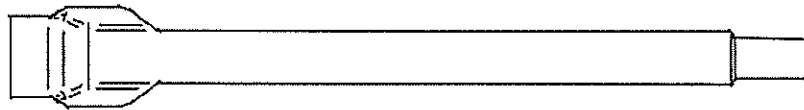


Tabelle: installation details

Anchor name		“Friulsider Injection system KEM-UP 934” bonded anchor							
		M8	M10	M12	M16	M20	M24	M27	M30
Anchor size									
Nominal drill diameter	$d_0$ [ mm ]	10	12	14	18	24	28	32	35
Depth of borehole	$h_0$ [ mm ]	80	90	110	125	170	210	250	280
Minimum set depth	$h_{ef}$ [ mm ]	80	90	110	125	170	210	250	280
Min. member thickness	$h_{min}$ [ mm ]	110	120	140	160	220	260	304	340
Torque	$T_{inst}$ [ Nm ]	10	20	40	80	120	160	180	200

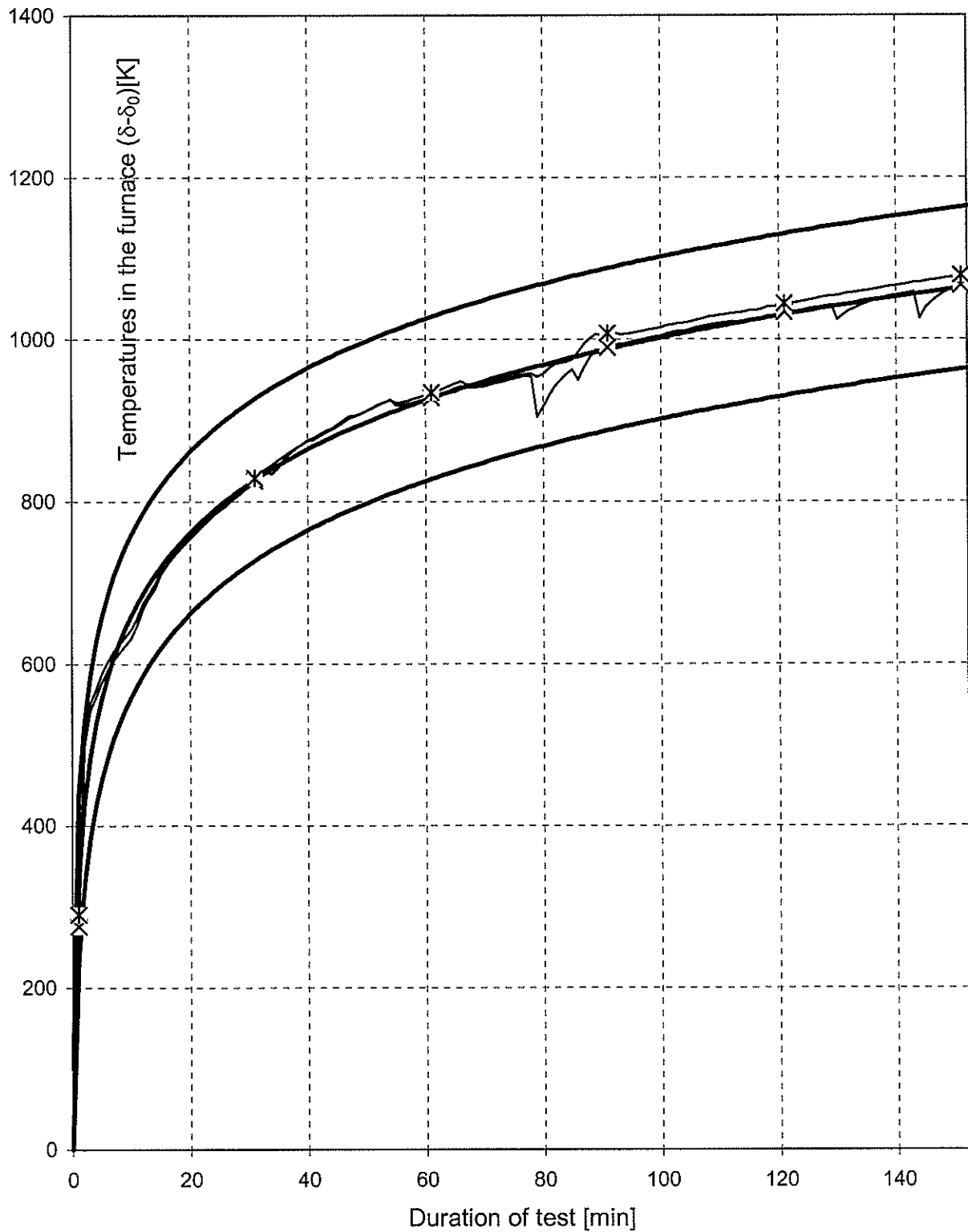
### Technical data

“Friulsider Injection system KEM-UP 934” bonded anchor

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 Institut für Baustoffe, Massivbau und Brandschutz  
 der Technischen Universität Braunschweig

Annex 1.4 of  
 Test Report No.  
 (3764/829/09)-NB

ETK DIN EN 1363-1



— Soll. — Min. — Max. —x— T 51 —\*— T 53

$\delta_0 = 24 \text{ }^\circ\text{C}$

test date: 27.06.08

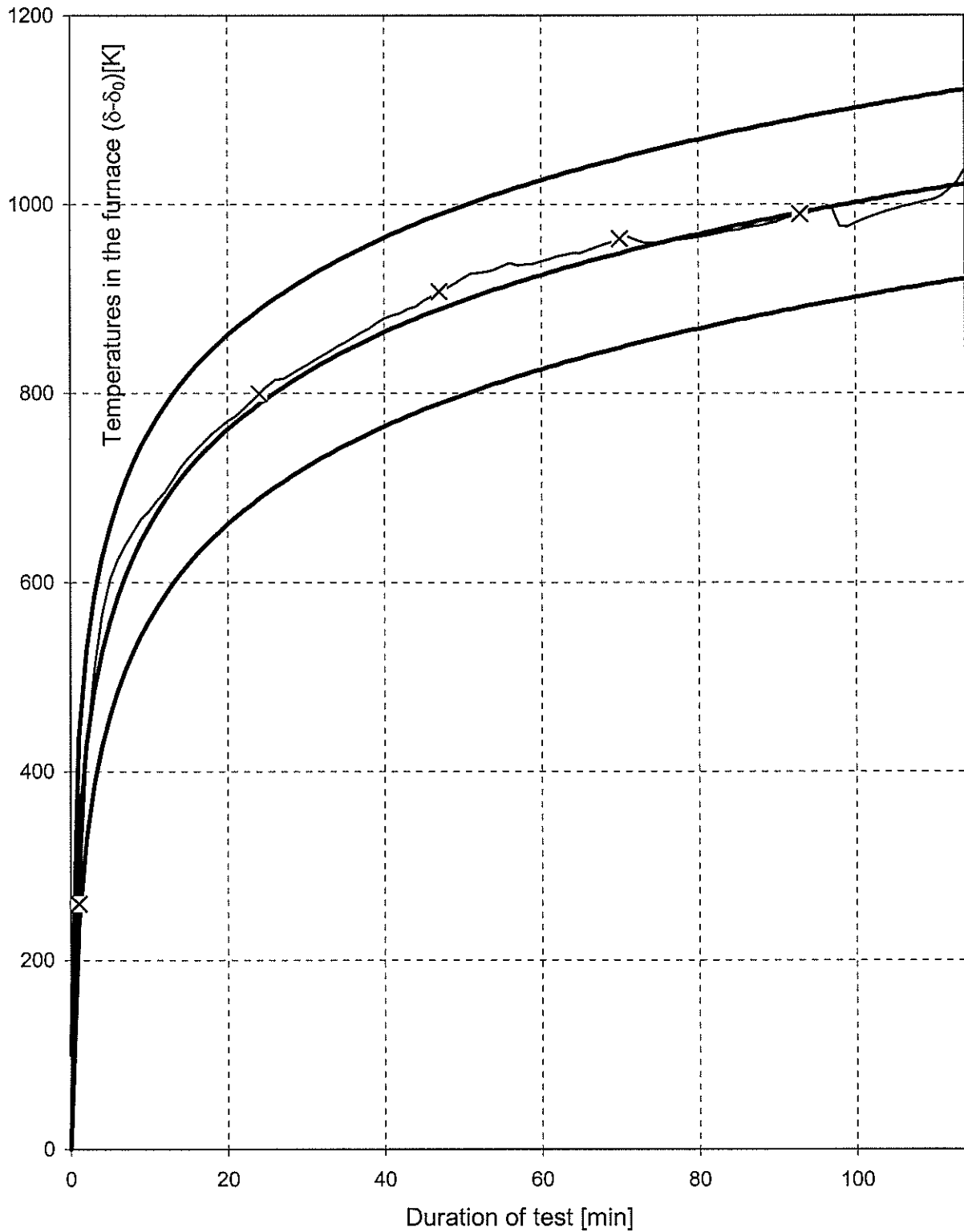
Temperatures in the furnace  
test 1

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der Technischen Universität Braunschweig

Annex 2.1 of  
Test Report

No. (3764/829/09)-NB

ETK DIN EN 1363-1



$\delta_0 = 21 \text{ }^\circ\text{C}$

test date: 27.08.08

Temperatures in the furnace  
test 2

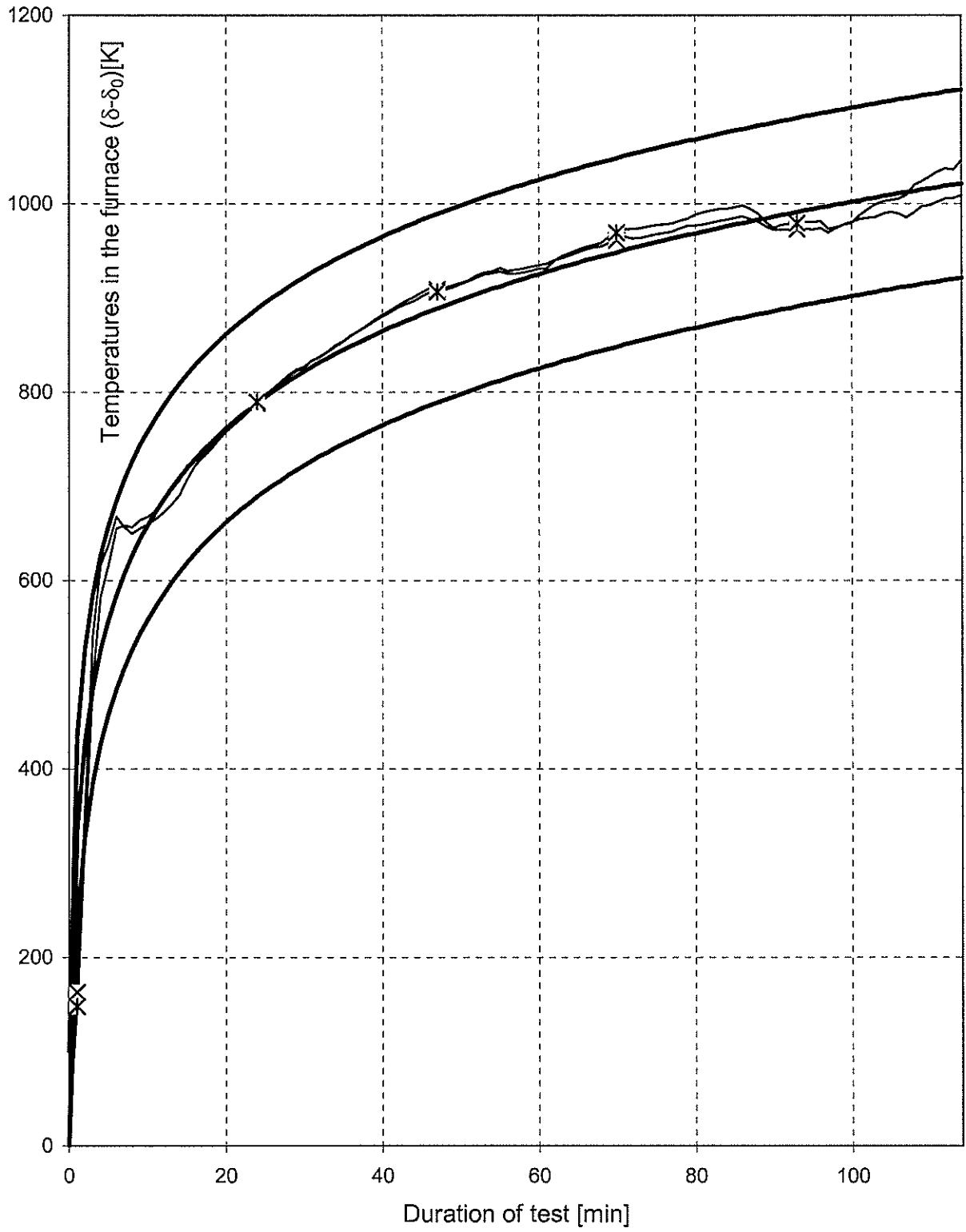
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Institut für Baustoffe, Massivbau und Brandschutz  
der Technischen Universität Braunschweig

Annex 3.1 of

Test Report

No. (3764/829/09)-NB

ETK DIN EN 1363-1



$\delta_0 = 21 \text{ }^\circ\text{C}$

test date: 01.09.08

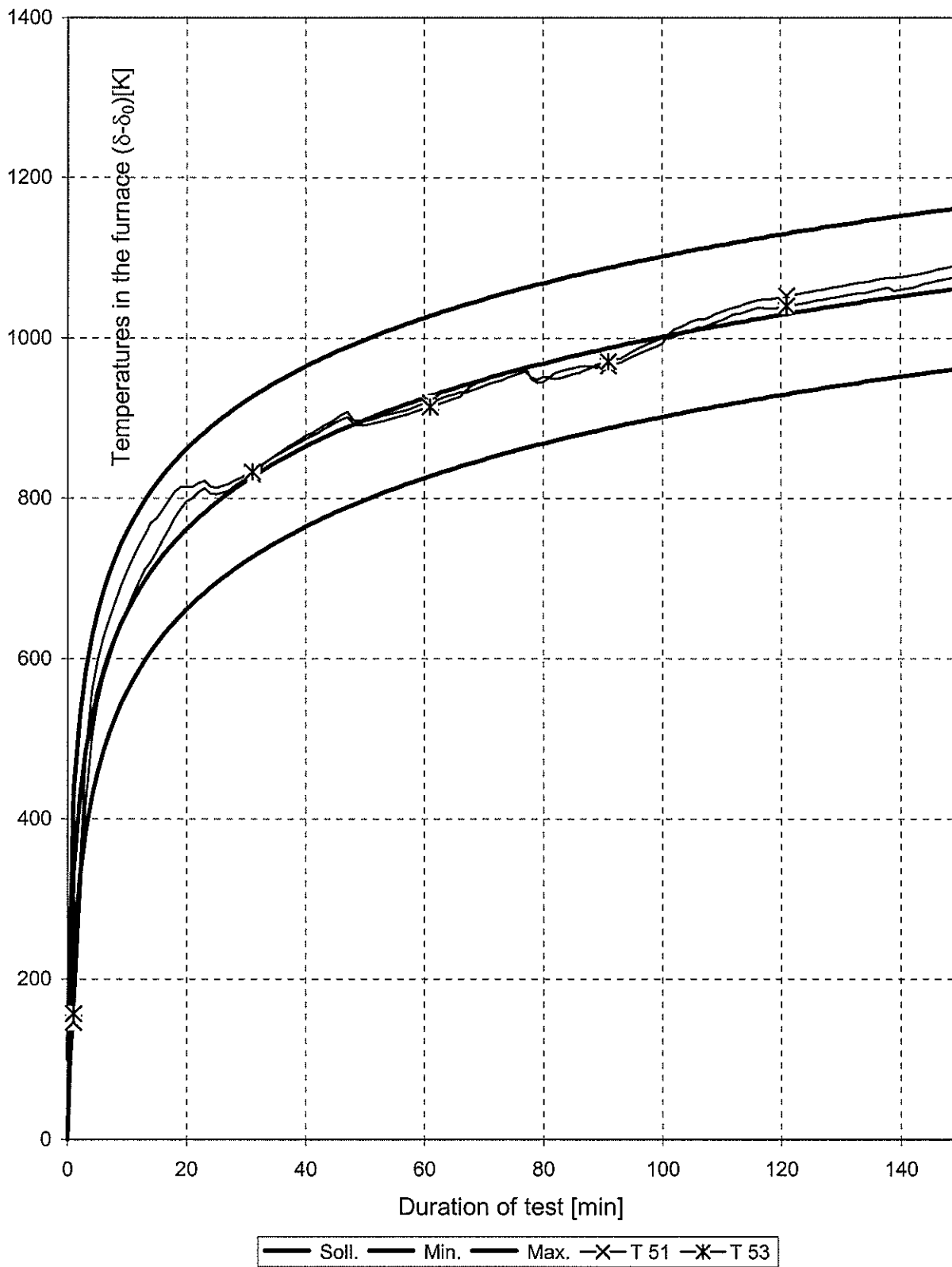
Temperatures in the furnace  
test 3

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Annex 4.1 of  
Test Report

No. (3764/829/09)-NB

# ETK DIN EN 1363-1



$\delta_0 = 18 \text{ }^\circ\text{C}$

test date: 30.09.08

Temperatures in the furnace  
test 4

Materialprüfanstalt für das Bauwesen  
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Annex 5.1 of

Test Report

No. (3764/829/09)-NB



## Companion Sheet to Test Report

- Translation -

Document No.: (3764/829/09) – NB dd. 10/03/2009

Client: FRIULSIDER SPA  
Via Trieste 1  
33048 San Giovanni al Natisone

Order date: 09/03/2009

Order Ref.: Ms Novello

Order received: 09/03/2009

Subject: “Friulsider Injection system KEM-UP 934” bonded anchors, placed in non-cracked RC members and subjected to centric tension loads, to be tested and evaluated in connection with anchor rods (dimensions M8 to M30) for their reaction to fire to determine their fire resistance time for one-sided fire exposure

Test basis: DIN EN 1363-1 : 1999-10

Test material received: 11/06/2008

Sampling: Sampling information is not available to the Testing House.

Test material marking: None

Test date: 27/06/2008, 27/08/2008, 01/09/2008 and 30/09/2008

Valid until: 7 January 2014



This Companion Sheet consist of 4 pages, incl. cover sheet.

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## 1 Background and general statement

Under the order placed with the Testing House, a Test Report was to be drawn up on the reaction to fire of “Friulsider Injection system KEM-UP 934” bonded anchors, which are subjected to centric tension and tested for steel failure / bonding failure on the basis of section 2.3 of TR 020 : 2004-05, when exposed to a fire in compliance with DIN EN 1363-1 : 1999-10 to determine their fire resistance time.

Related documents:

- (1) DIN EN 1363-1 : 1999-10, Fire resistance tests - Part 1: General requirements,
- (2) EOTA Technical Report TR 020 : 2004-05 - Evaluation of anchorages in concrete concerning resistance to fire,
- (3) “Friulsider Injection system KEM-UP 934”, European Technical Approval ETA-09/0061 16-02-2009, issued by DIBt, Berlin.

Using the results achieved in the fire test, the “Friulsider Injection system KEM-UP 934” bonded anchors were to be examined and evaluated respecting requirements (steel failure, pullout) specified in EOTA Technical Report TR 020 : 2004-05.

## 2 Proposed rating for the “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 to M30) in connection with anchor rods made from electrogalvanised steel (strength class 5.6)

Using the test results achieved for “Friulsider Injection system KEM-UP 934” bonded anchors made from electrogalvanised steel (strength class 5.6) as a basis, fire resistance periods are proposed for the “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 to M30) made from electrogalvanised steel (strength class 5.6, 5.8 and 8.8) as a function of the maximum centric tensile load as shown in table 2-1 below.

Based on the results achieved in the tests, and departing from the evaluation specifications in TR 020 : 2004-05, the ratings for “Friulsider Injection system KEM-UP 934” bonded anchors made from galvanised steel have been increased with regard to the 30-minute fire resistance time.

Table 2-1-: Proposed rating for “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 – M30) made from electrogalvanised steel, regarding their fire resistance times as a function of stress  $\sigma$  when exposed to centric tensile loads, and as a function of the minimum set depth

Designation	“Friulsider Injection system KEM-UP 934” bonded anchor							
Fire resistance time $t_u$ [min]	Maximum tensile load <sup>1)</sup>							
	F [kN]							
	M8	M10	M12	M16	M20	M24	M27	M30
Minimum set depth [mm]	80	90	110	125	170	210	250	280
30	0.90	3.20	4.20	8.25	17.25	24.85	32.30	39.50
60	0.50	1.80	2.30	5.30	10.20	14.75	19.15	23.40
90	0.30	1.10	1.40	3.80	6.70	9.70	12.60	15.40
120	0.20	0.75	0.90	3.00	5.00	7.20	9.30	11.35

<sup>1)</sup> Loads resulting from European Technical Approval ETA-09/0061 may be decisive for the service condition.

### 3 Proposed rating for “Friulsider Injection system KEM-UP 934” bonded anchors (dimensions M8 – M30) in connection with anchor rods made from stainless steel

Starting from the results achieved in the tests, the same characteristic tensile stresses (cf. table 2-1) are recommended for the “Friulsider Injection system KEM-UP 934” bonded anchors, when adequate anchor rods and nuts made from stainless steel (material No. 1.4401 (A4) and 1.4571 (A5), 1.4529 (HCR) strength class 50 and 70, respectively) are used.

## 4 Annotations

- 4.1** This Test Report does not replace the required building code attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA). It should, in particular, be noted that the fire load density values of “Friulsider Injection system KEM-UP 934” bonded anchors can be regulated by European Technical Approvals.
- 4.2** The above evaluation shall only apply to the tested “Friulsider Injection system KEM-UP 934” bonded anchors, due consideration being given to the boundary conditions shown in the technical annexes attached to this Test Report and/or the technical data sheets of Friulsider Spa.
- 4.3** The “Friulsider Injection system KEM-UP 934” bonded anchors may be used for anchoring applications in non-cracked reinforced concrete (strength class C20/25 as a minimum and C50/60 as a maximum) when primarily subjected to static loads.
- 4.4** The evaluation shall only apply in connection with members made from reinforced concrete, which can as a minimum be classified under the same fire resistance class as that of the anchors.
- 4.5** The validity of the Test Report will expire on 7 January 2014.

*Rohling*  
ORR Dr.-Ing. Rohling  
Head of Testing Laboratory



i.A. *Bollmohr*  
Dipl.-Ing. Bollmohr  
Engineer in charge

Braunschweig, dated 10 March 2009